THE OSCILLOGRAPHER

Vol. 10, No. 1 January - March, 1948

Allen B. Du Mont Laboratories, Inc., 2 Main Ave., Passaic, N. J. — A view of Plant 1 where Du Mont cathode-ray tubes are developed and manufactured.

Beginning with this issue, the Oscillographer will appear quarterly instead of bi-monthly, and its size will be increased, to enable us to better fulfill the purpose of this publication. These changes will permit the regular appearance of application notes and items of current interest, in addition to at least one feature article plus a bibliography of technical papers on cathode-ray instruments and related apparatus. We feel certain that the inclusion of this material will provide a more interesting and useful publication.

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THE TYPE 271-A OSCILLOGRAPH-RECORD CAMERA

By

Carl Berkley*

There has been a need for some time for a reliable and foolproof cathode-ray oscillograph camera the operation of which requires a minimum of photographic training and manipulation. A camera has numerous applications in oscillography, since it converts a device which would otherwise be only a waveshape indicator into a recording instrument. Such an instrument can be used by the research worker to obtain accurate records of variations in operation due to slight changes in a circuit or a device as shown in Figure 2. The camera can be used for quality control as, for example, during television receiver manufacture, to make a record of picture quality for each receiver, and in other production tests, to have a permanent record of performance for the purpose of proving the attainment of particular specifications.

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The use of a rigidly-mounted camera on a cathode-ray oscillograph immediately improves the accuracy with which a measurement can be made, since the recording is not subject to the parallax of an observer whose viewpoint may be shifted. Accurate measurements of amplitude can be made by recording the signal from a Du Mont Type 264-A Voltage Calibrator exposed on the same film as the phenomenon being studied.

A camera is a mandatory adjunct to a cathode-ray oscillograph when persistence is insufficient as in the case of a very-high-speed transient or in the case of a phenomenon of such duration that visual persistence fails to give readable results. A suitable camera can also serve to make a series of repeated pictures in short order to show the effects of aging or warm-up in a circuit. A camera can be used to record random phen-

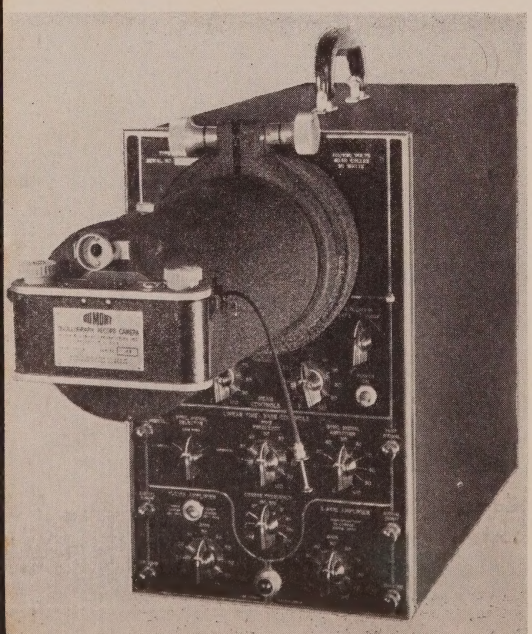

Figure 1—The Du Mont Type 271-A Oscillograph-record Camera and Adapter Attached to a Du Mont Type 208-B Cathode-ray Oscillograph.

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The purpose of this publication is to provide information on new developments and applications of the cathode-ray oscillograph and related apparatus.

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omena, whose occurence cannot be predicted, by the use of a cathode-ray oscillograph having a single sweep and beam-blanking. It can also be used to compare two or more phenomena at once, such as are obtained in work with multi-beam cathode-ray tubes and cathode-ray oscillographs. Finally, a photographic recording can be subjected to as detailed a Fourier analysis of any waveform as may be desired to determine accurately the components present in a signal.

The Type 271-A Oscillograph-record Camera was developed jointly by Allen B. Du Mont Laboratories, Inc., and Eastman-Kodak Company to fill this need. This camera is a complete instrument and may be used separately with any type of oscillograph or cathode-ray tube; an adapter has been especially designed to attach the camera to standard five-inch cathode-ray oscillographs. This adapter forms a light-tight connection between the cathode-ray oscillograph and the camera, obviating the use of a dark room, and it also serves to keep the camera in constant focus. The adapter has a clamping ring which will fit, without any changes, the Du Mont Types 208-B, 213-A, 241, 256-D, 279, 280 Cathode-ray Oscillographs and the Type 281 Cathode-ray Indicator. A mounting bezel to adapt the camera to other types of cathode-ray oscillographs is supplied with each camera.

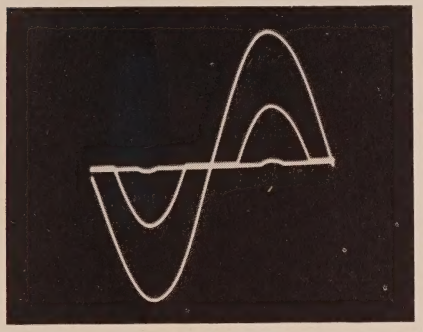

Figure 2

Triply-exposed Oscillogram, from a Type 247 *Oscillograph, Showing the Effect of Varying the "Constants" in a Peak-clipping Circuit. This photograph illustrates the possibility of detecting very slight changes in circuit operation with the aid of the Type* 271-*A Camera.*

Design Considerations

The design of the Type 271-A Oscillograph-record Camera was governed by the following factors:

1. Cost (Lens) — The price of high-speed lenses increases rapidly with increase in size. For this reason a 35-mm camera was decided upon, for which numerous high-speed lenses are available at moderate cost. Where many recordings are to be made, such as in production tests, or for example, in complete specification of a complex circuit by recordings of waveshapes at many test points (as in a television receiver), the saving resulting from the use of 35-mm film will be appreciable. Of particular interest in this application is the use of the 1/30-second shutter speed which makes possible the exposure of only one frame of a television raster. There is no necessity for a wide range of shutter speeds since the exposure is generally controlled by electronic means in the oscillograph.

2. **Speed** — The image brightness, and therefore the highest recording speed obtainable, depends upon the light-transmission of the lens system. Considering two lenses of the same construction and f value, the shorter focal-length lens will have a higher light-transmission since the rays will travel through a shorter glass path. The image brightness is also a function of the ratio between image and object sizes. Figure 3 is a graph showing the increase in picture brightness as the magnification is decreased. This increase has a maximum value of four times compared to the brightness at unity magnification. Since a suitable reduction ratio is about 5:1, the brightness increase will be of the order of three times. This is another advantage of a short-focal-length lens, as this reduction may be accomplished within a small distance from the cathode-ray tube. The lens elements should be coated, since this also results in an increased light transmission.

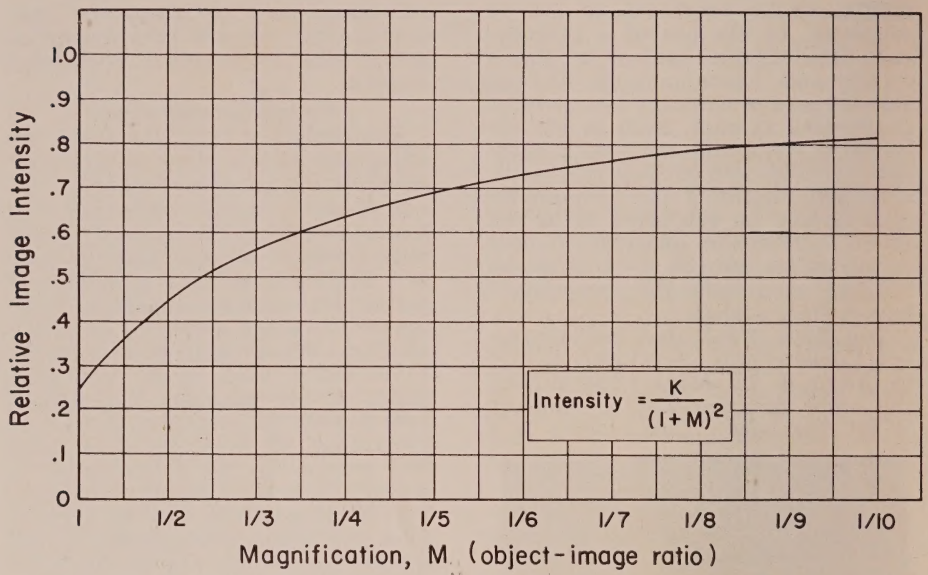

Figure 3—Variation of Image Intensity with Magnification.

3. **Depth of Field**—It is well known that short-focus lenses give a greater depth of field for a given distance between object and image. This is another advantage of a 35-mm camera. The camera should be capable of showing the entire curved face of the cathode-ray tube in focus even at larger apertures. Although the picture is smaller, there is no loss of detail as can be seen from Figures 4 - 6; and the negative may be enlarged to any desired size for printing or may be projected with any standard slide-film projector for observation. A particularly convenient method for studying the recordings employs a microfilm reader which projects the image on a sheet of metrically ruled graph paper. Since the projection distance is fixed, the paper may be calibrated directly in volts, by the use of a Du Mont Type 264-A Voltage Calibrator, and in seconds (by the use of an oscillator) and used to read the recordings. *Details invisible on the cathode-ray oscillograph are sometimes made visible by this procedure.*

4. **Film Size**—The use of 35-mm film cartridges has the advantage that the cartridges may be easily loaded into the camera without the necessity for a dark room, and may be developed without a dark room by the use of a Kodak 35-mm daylight-loading tank. If desired, these cartridges may be sent to any photo-finishing laboratory for development by standard procedures. If the setting of the film-counter is noted, the film may be stopped at any frame and the cartridges removed in order to change the film, or to make comparative recordings on the same piece of film at a later date. Each standard cartridge has numbers imprinted on the film which appear during development, thus identifying each frame. Any standard amateur film may be used to make low-speed recordings, since the exposure obtained is adequate to obtain the required density.

Two special recording films for oscillograph-recording purposes are obtainable from the Eastman Kodak Company. These are Kodak Linagraph Ortho film Type 5211, and Kodak Linagraph Pan film Type 5244. The Linagraph Pan film (panchromatic) has yielded the highest photographic recording speeds with the P11, blue, short-persistence screens. The Panchromatic film is always preferred for oscillographs

having P2, green-yellow, long-persistence screens, which are employed for both direct observation and photographic recording. The highest recording speeds will be obtained using tubes with P11 screens.

Development Technique

The maximum writing rate* which can be recorded with a particular oscillograph and cathode-ray tube will depend to a great extent upon the treatment the film receives during development. Where adequate exposure is available, ordinary photofinishing methods may be used, i.e., M-Q developer diluted 1:1, since these developers produce a high degree of contrast. If pictures are to be enlarged for reproduction, the use of a fine-grain film, such as Eastman Panatomic X is desirable. With this film, 4-inch by 5-inch enlargements can be obtained without noticeable grain, even when strong developers are used.

Where very high-speed transients are to be recorded, exceptionally vigorous development is required. This may be prolonged to the point where a chemical fog is obtained in order to obtain the maximum recorded density. The figures in the table (Pg. 6) are based upon the use of Linagraph Pan film developed to just below the point of excessive fogging in SD19-A developer for ten to twenty minutes.

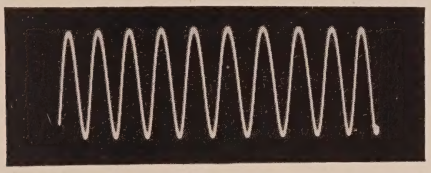

Figure 4
Recording of a 10-kc Sine Wave on a Du Mont Type 208-B Cathode-ray Oscillograph (Exposure of ½ sec at f/3.5; P11 screen and medium setting of intensity control).

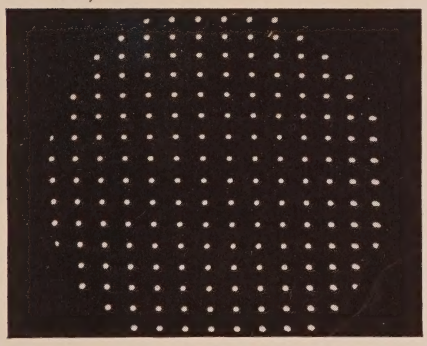

Figure 5
Matrix Produced on a 60 by 3000-cycle Raster by 2-μsec Grid Pulses (Exposure of 1 sec at f/3.5; Type 5CP11A cathode-ray tube with 3 kv accelerating potential).—Note good resolution to edges of picture.

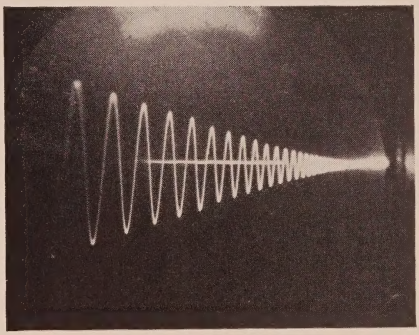

Figure 6
Two-megacycle Damped Oscillation Recorded with a Type 271-A Camera on a Du Mont Type 281 Cathode-ray Indicator with a Type 286 High-voltage Power Supply.—Note variation of photographic density with writing rate.

*Writing rate is the linear velocity with which the fluorescent spot traverses the cathode-ray tube face. The maximum writing rate which can be recorded with a particular piece of equipment depends upon the brightness of the image, and the optical efficiency of the camera. Image brightness depends upon the total accelerating voltage, the beam current available, the spot size, the amount of grid-driving voltage, and the efficiency of the phosphor employed.

The optical efficiency of the camera is dependent upon the over-all transmission of the lens, the f value, and the object-to-image reduction ratio M.

In order to enable a direct comparison of different assemblies of equipment, the maximum writing rate which can be obtained with particular oscillographs or cathode-ray tubes under certain specified conditions of use, is referred to the standard conditions of use, f/1.0 and M=1. For the convenience of the user of the camera, the values of maximum writing rate tabulated on pg. 6 refer to the particular conditions obtained with this camera, that is, f/3.5 M=4.7:1. Maximum writing rates under standard conditions can readily be obtained by use of the conversion nomographs contained in the Du Mont catalog. In determining the theoretical maximum writing rate, the highest speed which produces a negative density of 0.1 above fog, using a high-sensitivity photographic emulsion and full development, is chosen.

Average Recording Speeds (Tentative) of Du Mont Cathode-ray Oscillographs with the Type 271-A Camera

Lens Aperature: f/3.5 Object-Image Ratio—4.5:1
Film: EK Linagraph Pan (5244) or E K Linagraph Ortho (5211)
Developed in SD-19a to a density of 0.1 above fog

Oscillograph Type	Tube Type	Maximum Accelerating Potential (Volts)		Maximum Photographic Writing Speed* with P11 Screen	
		Eb_2	Eb_3	inches per microsecond	kilometers per second
208-B	5LP11A	1120	1,400	0.04	1
213-A	5LP11A	1000	2,000	0.16	4
241	5JP11A	1100	1,500	0.04	1
247	5CP11A	1550	3,000	0.40	10
247-A with 263-A	5RP11A	1550	11,550	4.9	125
248	5JP11A	2000	4,000	0.63	16
248-A, 263-A	5RP11A	2000	12,000	8.7	220
256-D	5CP11A	2000	4,000	0.63	16
274	5BP11A	1000	1,000	0.02	0.5
275-A	5CP11A	1500	3,000	0.4	10
279	5SP11	1700	4,500	0.8	20
280	5RP11A	1900	11,900	7.86	200
288	5RP11A	1900	19,000	11.8	300
281	5RP11A	4000	8,000	7.1	180
281, 263-A	5RP11A	4000	14,000	17.7	450
281, 286	5RP11A	4000	29,000	35.0	874

*Referred to the image on the cathode-ray tube face. This figure is given by $V_{max}=2\pi FA$ for a sine wave of frequency F and half the peak-to-peak amplitude equal to A with the intensity control set at maximum.

Although particular instruments will deviate from these values, they represent typical average values, obtained by the use of high-speed film and prolonged development for maximum recording density. The rated test voltages for the instrument are listed in the table next to each tube. Since these voltages may be increased, in most cases, higher speeds may be recorded using these tubes at their maximum ratings.

No difficulty will be encountered with the Type 271-A Oscillograph-record Camera and adapter in the recording of repetitive phenomena since the exposure may be prolonged in order to obtain suitable density on the film.

Work on high-speed transient photography is constantly in progress at Allen B. Du Mont Laboratories. Information as to specific problems in photographic technique can be obtained by addressing inquiries to the Cathode-ray Instrument Division, 1000 Main Avenue, Clifton, New Jersey.

Specifications

1. **Camera** — The camera is a modified Eastman Kodak 35-mm camera, normally equipped with a 2-inch f/3.5, three-element special anastigmat lens, with non-reflecting coatings which increase its light transmission. The use of only three elements reduces light absorption. A Dakon shutter, having speed settings of 1/30th of a second, "bulb" and "time", and an iris diaphragm continuously variable from full aperature to f/16, is attached. A cable release is brought to the outside of the camera housing through a light-tight coupling. The lens mount is adjusted at the factory to focus at a distance of 10¾ inches from the front element of the lens. When used with the adapter, this distance is automatically set by means of a ring which contacts with the face of the cathode-ray tube.

The camera will accept standard 35-mm film cartridges containing up to 36 exposures. Special oscillographic films are available in these cartridges. A winding knob moves the film and a counter indicates the number of exposed frames. When completely exposed, the film may be rewound back into the cartridge. If a few pictures are exposed, the film may be rewound, and a cartridge with a different type of film may be substituted.

Figures 4-6 show a number of single-frame recordings. Although

these recordings were made at maximum aperature of f/3.5, the depth of field of the lens is sufficient to eliminate any noticeable defocusing caused by the curvature of the face of the cathode-ray tube.

2. **Adapter** — The adapter consists of a tube, one end of which is attached to the oscillograph, while the other end is attached to the camera. The adapter has a rubber ring at its front end which contacts the face of the cathode-ray tube, ensuring correct focus on the cathode-ray tube screen. The screen may be viewed for adjustment purposes through a viewing aperature located above the camera. This aperature is visible in Figure 1. The aperature may be closed to avoid fogging of the film by extraneous light. The camera may be readily removed from the adapter for adjustment of the shutter and iris. It is held in place by a bayonet mount and a locking pin. Two reference lines facilitate placing the camera vertically or horizontally with respect to the cathode-ray tube sweep axis.

Specifications

Lens Speed—f/3.5, with iris diaphragm from f/3.5 to f/16
Shutter Speeds—Time, Bulb, and 1/30 second
Focus—Fixed—10.75 inches from front element of lens
Object-to-Image Ratio—approximately 4.7:1
Negative Emulsions Available—Any 35-mm roll film in standard cartridges may be employed
Maximum Diameter of Mounting Clamp—6 inches
Maximum Diameter of Body at Center—4¾ inches
Maximum Inside Diameter of Clamping Ring—5½ inches
Minimum Inside Diameter of Clamping Ring—5 3/16 inches
Overall Length—13½ inches
Weight—4½ pounds.

Catalog Number	Type	Description	Code Word
1216-E	271-A	Oscillograph - record Camera including the Type 2501 Mounting Bezel	YALAR
1215-E	2501	Mounting Bezel for Type 271-A	YALAP

References

1. "Photographing Patterns on Cathode-ray Tubes," by R. Feldt, Electronics, February, 1944.
2. "Photography of Cathode-ray Tube Traces," by N. Hendry, Electronic Engineering, January, 1944 (pages 324-326).
3. "The Recording of High Speed Transient Phenomena," by W. Nethercot, Electronic Engineering, February, 1944 (pages 369-371).

SCHERAGA ADDRESSES TEXTILE GROUP

The application of the cathode-ray oscillograph to the design and production control of textile machinery was described by Morton G. Scheraga of the Technical Sales Dept. in a lecture before the 18th Annual Meeting of the Textile Research Institute, held at the Waldorf-Astoria on November 14th.

The talk outlined the work done in joint research programs during the past year between Du Mont and several textile organizations including the Forstmann Woolen Company, Textile Research Institute, Clemson College, and the Singer Sewing Machine Company. This program was carried out as part of Du Mont's pioneering efforts in solving intricate mechanical problems with cathode-ray equipment.

Much of the engineering and consulting work was accomplished by Messrs. Meyer Maron and Carl Berkley of the Applications Engineering Section, Allen B. Du Mont Laboratories, Inc.

NEW CRO EQUIPMENT DEMONSTRATED AT NEC

The Instrument Div. had an extensive exhibit of oscillographic equipment at the National Electronic Conference, held in Chicago on November 3-6. Featured in the display were several new instruments being shown to the public for the first time: the Types 279 Dual-beam Oscillograph, 314 Oscillograph-record Camera, 271-A Oscillograph-record Camera, 281 Cathode-ray Indicator, and 286 High-voltage Power Supply.

On the day before the conference, a sales conference was held for Du Mont representatives who assembled from all over the country. At this meeting, members of the Sales and Engineering departments lectured on the new equipment in the instrument line and their research and industrial applications. Lectures were given by Messrs. Rudolf Feldt and Carl Berkley before two of the panel sections of the conference.

The company was represented by the following men of the Instrument Div.: G. Robert Mezger, Emil Nichols, Morton Scheraga, Rudolf Feldt, P. S. Christaldi, Carl Berkley, Harry Phelps, and Frank Timmons.

OBITUARIES

Dr. Vladimir Nikitich Karapetoff, noted professor, author, lecturer, consultant engineer, inventor, poet, and musician, died in New York on January 11 at the age of 72; death was caused by a coronary occlusion.

Dr. Karapetoff received his civil engineering degree in 1897, and his degree of master of mechanical engineering in 1902 from the Institute of Ways of Communications in St. Petersburg, Russia. He studied electrical engineering at Technische Hochschule in Germany.

A member of Sigma Xi, Tau Beta Pi, Eta Kappa Nu, Phi Mu Alpha, and Professor Emeritus of Electrical Engineering, Dr. Karapetoff was a member of the faculty of Cornell University from 1904 to 1939.

James G. Biddle, founder of the well known James G. Biddle Co., of Philadelphia, manufacturers of electrical and scientific instruments, died on December 21 at the age of 79.

James H. McGraw died on February 21 at the age of 87. The dean of industrial publishers founded the McGraw-Hill Publishing Company—the largest industrial publishing organization in the world.

BIBLIOGRAPHY

Technical Papers on Cathode-ray Oscillography and Related Subjects

Beginning with this issue, and appearing as a regular feature, the Oscillographer will contain a chronological list of articles that pertain to the design, manufacture, application, and sale of cathode-ray oscillographs and auxiliary apparatus.*

1. "A New Calibrated Oscillograph," by Nagy, P., Electronic Engineering[1], Sept. 1945, vol. 17, p. 688.

2. "Oscillographe Cathodique Appareil de mesure universel," by Laisne, M., Société des Ingénieurs Civils de France—Memoires, Jan.-April, 1946, vol. 99, no. 1-4, P. 29. (*Illustrated description of the cathode-ray oscillograph as a universal measuring instrument for electrical, optical, acoustical, mechanical, chemical, and biological purposes.*)

3. "Simplification of Cathode-ray Tube Design by the Application of the Theory of Similitude," by Moss, H., Jr. Television Society[2], March 1946, vol. 4, p. 206.

4. "R-F H-T Power Supplies for Cathode-ray Tubes," by Boadle, R. U., AWA[3] Tech. Rev., Sept. 1946, vol. 7, no. 1, p. 53.

5. "The Measurement of Current Transients in a Low Voltage Circuit," by Barnes, Adams, and Hinman, Rev. of Sci. Instruments[4], Oct. 1946, vol. 17, p. 426.

6. "Improved Electronic Engine Indicator," by Walker, A. H., Engineering[5], Oct. 18, 1946, vol. 162, p. 361.

*Lists occasionally omitted due to space limitation will be added to subsequent issues.
[1]London — monthly.
[2]Berks, England — irregular.
[3]Amalgamated Wireless Australasia Ltd., Sydney — irregular.
[4]American Institute of Physics, N. Y.—monthly.
[5]London — weekly.